

## **AMENDMENTS TO THE CLAIMS**

This listing of claims will replace all prior versions, and listings, of claims in the application:

### **Listing of Claims:**

- 1        1. (Currently amended) A method for using a computer system to solve a  
2 global inequality constrained optimization problem specified by a function  $f$  and a  
3 set of inequality constraints  $p_i(\mathbf{x}) \leq 0$  ( $i=1, \dots, m$ ), wherein  $f$  and  $p_i$  are scalar  
4 functions of a vector  $\mathbf{x} = (x_1, x_2, x_3, \dots, x_n)$ , the method comprising:  
5            receiving a representation of the function  $f$  and the set of inequality  
6 constraints at the computer system;  
7            storing the representation in a memory within the computer system;  
8            performing an interval inequality constrained global optimization process  
9 to compute guaranteed bounds on a globally minimum value of the function  $f(\mathbf{x})$   
10 subject to the set of inequality constraints;  
11            wherein performing the interval global optimization process involves,  
12                  applying term consistency to the set of inequality  
13 constraints over a sub-box  $\mathbf{X}$ , and  
14                  excluding any portion of the sub-box  $\mathbf{X}$  that is proved to be  
15 in violation of at least one member of the set of inequality  
16 constraints; and  
17            recording the guaranteed bounds in the computer system memory;  
18            wherein applying term consistency involves:  
19                  symbolically manipulating an equation within the computer  
20                  system to solve for a term,  $g(\mathbf{x}')$ , thereby producing a modified

21           equation  $g(\mathbf{x}') = h(\mathbf{x})$ , wherein the term  $g(\mathbf{x}')$  can be analytically  
22           inverted to produce an inverse function  $g^{-1}(\mathbf{y})$ ;  
23           substituting the sub-box  $\mathbf{X}$  into the modified equation to  
24           produce the equation  $g(\mathbf{X}') = h(\mathbf{X})$ ;  
25           solving for  $\mathbf{X}' = g^{-1}(h(\mathbf{X}))$ ; and  
26           intersecting  $\mathbf{X}'$  with the  $j$ -th element of the sub-box  $\mathbf{X}$  to  
27           produce a new sub-box  $\mathbf{X}^+$ ;  
28           wherein the new sub-box  $\mathbf{X}^+$  contains all solutions of the  
29           equation within the sub-box  $\mathbf{X}$ , and wherein the size of the new  
30           sub-box  $\mathbf{X}^+$  is less than or equal to the size of the sub-box  $\mathbf{X}$ .

1       2. (Previously presented) The method of claim 1, further comprising:  
2           linearizing the set of inequality constraints to produce a set of linear  
3           inequality constraints with interval coefficients that enclose the nonlinear  
4           constraints;  
5           preconditioning the set of linear inequality constraints through additive  
6           linear combinations to produce a preconditioned set of linear inequality  
7           constraints;  
8           applying term consistency to the set of preconditioned linear inequality  
9           constraints over the sub-box  $\mathbf{X}$ , and  
10          excluding any portion of the sub-box  $\mathbf{X}$  that violates any member of the set  
11          of preconditioned linear inequality constraints.

1       3. (Original) The method of claim 2, further comprising:  
2           keeping track of a least upper bound  $f_{\text{bar}}$  of the function  $f(\mathbf{x})$  at a feasible  
3           point  $\mathbf{x}$  wherein  $p_i(\mathbf{x}) \leq 0$  ( $i=1, \dots, m$ ); and  
4           including  $f(\mathbf{x}) \leq f_{\text{bar}}$  in the set of inequality constraints prior to  
5           linearizing the set of inequality constraints.

1       4. (Original) The method of claim 2, further comprising removing from  
2 consideration any inequality constraints that are not violated by more than a  
3 specified amount for purposes of applying term consistency prior to linearizing  
4 the set of inequality constraints.

1       5. (Previously presented) The method of claim 1, wherein performing the  
2 interval global optimization process involves:

3             keeping track of a least upper bound  $f_{\text{bar}}$  of the function  $f(\mathbf{x})$  at a feasible  
4 point  $\mathbf{x}$ ;

5             removing from consideration any sub-box for which  $f(\mathbf{x}) > f_{\text{bar}}$ ;

6             applying term consistency to the  $f_{\text{bar}}$  inequality  $f(\mathbf{x}) \leq f_{\text{bar}}$  over the sub-  
7 box  $\mathbf{X}$ ; and

8             excluding any portion of the sub-box  $\mathbf{X}$  that violates the  $f_{\text{bar}}$  inequality.

1       6. (Previously presented) The method of claim 1, wherein if the sub-box  $\mathbf{X}$   
2 is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ), performing the interval global  
3 optimization process involves:

4             determining a gradient  $\mathbf{g}(\mathbf{x})$  of the function  $f(\mathbf{x})$ , wherein  $\mathbf{g}(\mathbf{x})$  includes  
5 components  $g_i(\mathbf{x})$  ( $i=1, \dots, n$ );

6             removing from consideration any sub-box for which  $\mathbf{g}(\mathbf{x})$  is bounded away  
7 from zero, thereby indicating that the sub-box does not include an extremum of  
8  $f(\mathbf{x})$ ; and

9             applying term consistency to each component  $g_i(\mathbf{x})=0$  ( $i=1, \dots, n$ ) of  $\mathbf{g}(\mathbf{x})=0$   
10 over the sub-box  $\mathbf{X}$ ; and

11             excluding any portion of the sub-box  $\mathbf{X}$  that violates any component of  
12  $\mathbf{g}(\mathbf{x})=\mathbf{0}$ .

1        7. (Previously presented) The method of claim 1, wherein if the sub-box  $\mathbf{X}$   
2 is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ), performing the interval global  
3 optimization process involves:

4              determining diagonal elements  $H_{ii}(\mathbf{x})$  ( $i=1, \dots, n$ ) of the Hessian of the  
5 function  $f(\mathbf{x})$ ;

6              removing from consideration any sub-box for which  $H_{ii}(\mathbf{x})$  a diagonal  
7 element of the Hessian over the sub-box  $\mathbf{X}$  is always negative, indicating that the  
8 function  $f$  is not convex over the sub-box  $\mathbf{X}$  and consequently does not contain a  
9 global minimum within the sub-box  $\mathbf{X}$ ;

10             applying term consistency to each inequality  $H_{ii}(\mathbf{x}) \geq 0$  ( $i=1, \dots, n$ ) over the  
11 sub-box  $\mathbf{X}$ ; and

12             excluding any portion of the sub-box  $\mathbf{X}$  that violates a Hessian inequality.

1        8. (Previously presented) The method of claim 1, wherein if the sub-box  $\mathbf{X}$   
2 is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ), performing the interval global  
3 optimization process involves:

4              performing the Newton method, wherein performing the Newton method  
5 involves,

6              computing the Jacobian  $\mathbf{J}(\mathbf{x}, \mathbf{X})$  of the gradient of the  
7 function  $f$  evaluated with respect to a point  $\mathbf{x}$  over the sub-box  $\mathbf{X}$ ,  
8              computing an approximate inverse  $\mathbf{B}$  of the center of  
9               $\mathbf{J}(\mathbf{x}, \mathbf{X})$ ,

10             using the approximate inverse  $\mathbf{B}$  to analytically determine  
11             the system  $\mathbf{B}\mathbf{g}(\mathbf{x})$ , wherein  $\mathbf{g}(\mathbf{x})$  is the gradient of the function  $f(\mathbf{x})$ ,  
12             and wherein  $\mathbf{g}(\mathbf{x})$  includes components  $g_i(\mathbf{x})$  ( $i=1, \dots, n$ );

13             applying term consistency to each component  $(\mathbf{B}\mathbf{g}(\mathbf{x}))_i = 0$  ( $i=1, \dots, n$ ) for  
14             each variable  $x_i$  ( $i=1, \dots, n$ ) over the sub-box  $\mathbf{X}$ ; and

15                   excluding any portion of the sub-box **X** that violates a component.

1                   9 (Canceled).

1                   10. (Original) The method of claim 1, further comprising performing the  
2                   Newton method on the John conditions.

1                   11. (Currently amended) A computer-readable storage medium storing  
2                   instructions that when executed by a computer cause the computer to perform a  
3                   method for using a computer system to solve a global inequality constrained  
4                   optimization problem specified by a function  $f$  and a set of inequality constraints  
5                    $p_i(\mathbf{x}) \leq 0$  ( $i=1, \dots, m$ ), wherein  $f$  is a scalar function of a vector  $\mathbf{x} = (x_1, x_2, x_3, \dots x_n)$ ,  
6                   the method comprising:

7                   receiving a representation of the function  $f$  and the set of inequality  
8                   constraints at the computer system;

9                   storing the representation in a memory within the computer system;  
10                  performing an interval inequality constrained global optimization process  
11                  to compute guaranteed bounds on a globally minimum value of the function  $f(\mathbf{x})$   
12                  subject to the set of inequality constraints;

13                  wherein performing the interval global optimization process involves,  
14                   applying term consistency to the set of inequality  
15                   constraints over a sub-box **X**, and  
16                   excluding any portion of the sub-box **X** that is proved to be  
17                   in violation of at least one member of the set of inequality  
18                   constraints; and  
19                  recording the guaranteed bounds in the computer system memory;  
20                  wherein applying term consistency involves:

21                   symbolically manipulating an equation within the computer  
22                   system to solve for a term,  $g(x'_j)$ , thereby producing a modified  
23                   equation  $g(x'_j) = h(\mathbf{x})$ , wherein the term  $g(x'_j)$  can be analytically  
24                   inverted to produce an inverse function  $g^{-l}(\mathbf{y})$ ;  
25                   substituting the sub-box  $\mathbf{X}$  into the modified equation to  
26                   produce the equation  $g(\mathbf{X}'_j) = h(\mathbf{X})$ ;  
27                   solving for  $\mathbf{X}'_j = g^{-l}(h(\mathbf{X}))$ ; and  
28                   intersecting  $\mathbf{X}'_j$  with the  $j$ -th element of the sub-box  $\mathbf{X}$  to  
29                   produce a new sub-box  $\mathbf{X}^+$ ;  
30                   wherein the new sub-box  $\mathbf{X}^+$  contains all solutions of the  
31                   equation within the sub-box  $\mathbf{X}$ , and wherein the size of the new  
32                   sub-box  $\mathbf{X}^+$  is less than or equal to the size of the sub-box  $\mathbf{X}$ .

- 1                   12. (Previously presented) The computer-readable storage medium of
- 2                   claim 11, wherein the method further comprises:
  - 3                   linearizing the set of inequality constraints to produce a set of linear
  - 4                   inequality constraints with interval coefficients that enclose the nonlinear
  - 5                   constraints;
  - 6                   preconditioning the set of linear inequality constraints through additive
  - 7                   linear combinations to produce a preconditioned set of linear inequality
  - 8                   constraints;
  - 9                   applying term consistency to the set of preconditioned linear inequality
  - 10                  constraints over the sub-box  $\mathbf{X}$ , and
  - 11                  excluding any portion of the sub-box  $\mathbf{X}$  that violates any member of the set
  - 12                  of preconditioned linear inequality constraints.

- 1                   13. (Original) The computer-readable storage medium of claim 12,
- 2                   wherein the method further comprises:

3        keeping track of a least upper bound  $f\_bar$  of the function  $f(\mathbf{x})$  at a feasible  
4    point  $\mathbf{x}$  wherein  $p_i(\mathbf{x}) \leq 0$  ( $i=1, \dots, m$ ); and  
5        including  $f(\mathbf{x}) \leq f\_bar$  in the set of inequality constraints prior to  
6    linearizing the set of inequality constraints.

1        14. (Original) The computer-readable storage medium of claim 12,  
2    wherein the method further comprises removing from consideration any inequality  
3    constraints that are not violated by more than a specified amount for purposes of  
4    applying term consistency prior to linearizing the set of inequality constraints.

1        15. (Previously presented) The computer-readable storage medium of  
2    claim 11, wherein performing the interval global optimization process involves:  
3        keeping track of a least upper bound  $f\_bar$  of the function  $f(\mathbf{x})$  at a feasible  
4    point  $\mathbf{x}$ ;  
5        removing from consideration any sub-box for which  $f(\mathbf{x}) > f\_bar$ ;  
6        applying term consistency to the  $f\_bar$  inequality  $f(\mathbf{x}) \leq f\_bar$  over the sub-  
7    box  $\mathbf{X}$ ; and  
8        excluding any portion of the sub-box  $\mathbf{X}$  that violates the  $f\_bar$  inequality.

1        16. (Previously presented) The computer-readable storage medium of  
2    claim 11, wherein if the sub-box  $\mathbf{X}$  is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ),  
3    performing the interval global optimization process involves:  
4        determining a gradient  $\mathbf{g}(\mathbf{x})$  of the function  $f(\mathbf{x})$ , wherein  $\mathbf{g}(\mathbf{x})$  includes  
5    components  $g_i(\mathbf{x})$  ( $i=1, \dots, n$ );  
6        removing from consideration any sub-box for which  $\mathbf{g}(\mathbf{x})$  is bounded away  
7    from zero, thereby indicating that the sub-box does not include an extremum of  
8     $f(\mathbf{x})$ ; and

9           applying term consistency to each component  $g_i(\mathbf{x})=0$  ( $i=1, \dots, n$ ) of  $\mathbf{g}(\mathbf{x})=\mathbf{0}$   
10       over the sub-box  $\mathbf{X}$ ; and  
11       excluding any portion of the sub-box  $\mathbf{X}$  that violates any component of  
12        $\mathbf{g}(\mathbf{x})=\mathbf{0}$ .

1           17. (Previously presented) The computer-readable storage medium of  
2       claim 11, wherein if the sub-box  $\mathbf{X}$  is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ),  
3       performing the interval global optimization process involves:

4           determining diagonal elements  $H_{ii}(\mathbf{x})$  ( $i=1, \dots, n$ ) of the Hessian of the  
5       function  $f(\mathbf{x})$ ;  
6           removing from consideration any sub-box for which  $H_{ii}(\mathbf{x})$  a diagonal  
7       element of the Hessian over the sub-box  $\mathbf{X}$  is always negative, indicating that the  
8       function  $f$  is not convex over the sub-box  $\mathbf{X}$  and consequently does not contain a  
9       global minimum within the sub-box  $\mathbf{X}$ ;  
10          applying term consistency to each inequality  $H_{ii}(\mathbf{x}) \geq 0$  ( $i=1, \dots, n$ ) over the  
11       sub-box  $\mathbf{X}$ ; and  
12          excluding any portion of the sub-box  $\mathbf{X}$  that violates a Hessian inequality.

1           18. (Previously presented) The computer-readable storage medium of  
2       claim 11, wherein if the sub-box  $\mathbf{X}$  is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ),  
3       performing the interval global optimization process involves:

4           performing the Newton method, wherein performing the Newton method  
5       involves,  
6               computing the Jacobian  $\mathbf{J}(\mathbf{x}, \mathbf{X})$  of the gradient of the  
7       function  $f$  evaluated with respect to a point  $\mathbf{x}$  over the sub-box  $\mathbf{X}$ ,  
8               computing an approximate inverse  $\mathbf{B}$  of the center of  
9        $\mathbf{J}(\mathbf{x}, \mathbf{X})$ ,

10 using the approximate inverse  $\mathbf{B}$  to analytically determine  
 11 the system  $\mathbf{B}\mathbf{g}(\mathbf{x})$ , wherein  $\mathbf{g}(\mathbf{x})$  is the gradient of the function  $f(\mathbf{x})$ ,  
 12 and wherein  $\mathbf{g}(\mathbf{x})$  includes components  $g_i(\mathbf{x})$  ( $i=1, \dots, n$ );  
 13 applying term consistency to each component  $(\mathbf{B}\mathbf{g}(\mathbf{x}))_i = 0$  ( $i=1, \dots, n$ ) for  
 14 each variable  $x_i$  ( $i=1, \dots, n$ ) over the sub-box  $\mathbf{X}$ ; and  
 15 excluding any portion of the sub-box  $\mathbf{X}$  that violates a component.

1 19 (Canceled).

1            20. (Original) The computer-readable storage medium of claim 11,  
2 wherein the method further comprises performing the Newton method on the John  
3 conditions.

1            21. (Currently amended) An apparatus for using a computer system to  
2 solve a global inequality constrained optimization problem specified by a function  
3  $f$  and a set of inequality constraints  $p_i(\mathbf{x}) \leq 0$  ( $i=1, \dots, m$ ), wherein  $f$  is a scalar  
4 function of a vector  $\mathbf{x} = (x_1, x_2, x_3, \dots, x_n)$ , the apparatus comprising:

a receiving mechanism that is configured to receive a representation of the function  $f$  and the set of inequality constraints at the computer system;

a memory within the computer system for storing the representation;

8 a global optimizer that is configured to perform an interval inequality  
9 constrained global optimization process to compute guaranteed bounds on a  
0 globally minimum value of the function  $f(\mathbf{x})$  subject to the set of inequality  
1 constraints;

12 a term consistency mechanism within the global optimizer that is  
13 configured to,

14 apply term consistency to the set of inequality constraints  
15 over a sub-box  $X$ , and to

16                    exclude any portion of the sub-box  $\mathbf{X}$  that is proved to be in  
17                    violation of at least one member of the set of inequality constraints;  
18                    and

19                    a recording mechanism that is configured record the guaranteed bounds in  
20                    the computer system memory;

21                    wherein the term consistency mechanism is configured to:

22                    symbolically manipulate an equation within the computer  
23                    system to solve for a term,  $g(\mathbf{x}'_j)$ , thereby producing a modified  
24                    equation  $g(\mathbf{x}'_j) = h(\mathbf{x})$ , wherein the term  $g(\mathbf{x}'_j)$  can be analytically  
25                    inverted to produce an inverse function  $g^{-1}(\mathbf{y})$ ;

26                    substitute the sub-box  $\mathbf{X}$  into the modified equation to  
27                    produce the equation  $g(\mathbf{X}'_j) = h(\mathbf{X})$ ;

28                    solve for  $\mathbf{X}'_j = g^{-1}(h(\mathbf{X}))$ ; and

29                    intersect  $\mathbf{X}'_j$  with the  $j$ -th element of the sub-box  $\mathbf{X}$  to  
30                    produce a new sub-box  $\mathbf{X}^+$ ;

31                    wherein the new sub-box  $\mathbf{X}^+$  contains all solutions of the  
32                    equation within the sub-box  $\mathbf{X}$ , and wherein the size of the new  
33                    sub-box  $\mathbf{X}^+$  is less than or equal to the size of the sub-box  $\mathbf{X}$ .

1                    22. (Previously presented) The apparatus of claim 21, further comprising:  
2                    a linearizing mechanism that is configured to linearize the set of inequality  
3                    constraints to produce a set of linear inequality constraints with interval  
4                    coefficients that enclose the nonlinear constraints; and  
5                    a preconditioning mechanism that is configured to precondition the set of  
6                    linear inequality constraints through additive linear combinations to produce a  
7                    preconditioned set of linear inequality constraints;  
8                    wherein the term consistency mechanism is configured to,

9                   apply term consistency to the set of preconditioned linear  
10                  inequality constraints over the sub-box  $\mathbf{X}$ , and to  
11                  exclude any portion of the sub-box  $\mathbf{X}$  that violates any  
12                  member of the set of preconditioned linear inequality constraints.

1                 23. (Original) The apparatus of claim 22, wherein the global optimizer is  
2                  configured to:

3                  keep track of a least upper bound  $f_{\text{bar}}$  of the function  $f(\mathbf{x})$  at a feasible  
4                  point  $\mathbf{x}$  wherein  $p_i(\mathbf{x}) \leq 0$  ( $i=1, \dots, m$ ); and to  
5                  include  $f(\mathbf{x}) \leq f_{\text{bar}}$  in the set of inequality constraints prior to linearizing  
6                  the set of inequality constraints.

1                 24. (Original) The apparatus of claim 22, wherein the term consistency  
2                  mechanism is configured to remove from consideration any inequality constraints  
3                  that are not violated by more than a specified amount for purposes of applying  
4                  term consistency prior to linearizing the set of inequality constraints.

1                 25. (Previously presented) The apparatus of claim 21,  
2                  wherein the global optimizer is configured to,

3                  keep track of a least upper bound  $f_{\text{bar}}$  of the function  $f(\mathbf{x})$   
4                  at a feasible point  $\mathbf{x}$ , and to  
5                  remove from consideration any sub-box for which  
6                   $f(\mathbf{x}) > f_{\text{bar}}$ ;  
7                  wherein the term consistency mechanism is configured to,  
8                  apply term consistency to the  $f_{\text{bar}}$   
9                  inequality  $f(\mathbf{x}) \leq f_{\text{bar}}$  over the sub-box  $\mathbf{X}$ , and to  
10                 exclude any portion of the sub-box  $\mathbf{X}$  that  
11                 violates the  $f_{\text{bar}}$  inequality.

1        26. (Previously presented) The apparatus of claim 21, wherein if the sub-  
2        box  $\mathbf{X}$  is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ):

3              the global optimizer is configured to,

4                  determine a gradient  $\mathbf{g}(\mathbf{x})$  of the function  $f(\mathbf{x})$ , wherein  $\mathbf{g}(\mathbf{x})$   
5                  includes components  $g_i(\mathbf{x})$  ( $i=1, \dots, n$ ), and to

6                  remove from consideration any sub-box for which  $\mathbf{g}(\mathbf{x})$  is  
7                  bounded away from zero, thereby indicating that the sub-box does  
8                  not include an extremum of  $f(\mathbf{x})$ ; and

9              the term consistency mechanism is configured to,

10             apply term consistency to each component  $g_i(\mathbf{x})=0$

11             ( $i=1, \dots, n$ ) of  $\mathbf{g}(\mathbf{x})=\mathbf{0}$  over the sub-box  $\mathbf{X}$ , and to

12             exclude any portion of the sub-box  $\mathbf{X}$  that violates any  
13             component of  $\mathbf{g}(\mathbf{x})=\mathbf{0}$ .

1        27. (Previously presented) The apparatus of claim 21, wherein if the sub-  
2        box  $\mathbf{X}$  is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ):

3              the global optimizer is configured to,

4                  determine diagonal elements  $H_{ii}(\mathbf{x})$  ( $i=1, \dots, n$ ) of the  
5                  Hessian of the function  $f(\mathbf{x})$ , and to

6                  remove from consideration any sub-box for which  $H_{ii}(\mathbf{x})$  a  
7                  diagonal element of the Hessian over the sub-box  $\mathbf{X}$  is always  
8                  negative, indicating that the function  $f$  is not convex over the sub-  
9                  box  $\mathbf{X}$  and consequently does not contain a global minimum within  
10               the sub-box  $\mathbf{X}$ ; and

11              the term consistency mechanism is configured to,

12             apply term consistency to each inequality  $H_{ii}(\mathbf{x}) \geq 0$   
13             ( $i=1, \dots, n$ ) over the sub-box  $\mathbf{X}$ , and to

14                    exclude any portion of the sub-box **X** that violates a  
15                    Hessian inequality.

1                 28. (Previously presented) The apparatus of claim 21, wherein if the sub-  
2                 box **X** is strictly feasible ( $p_i(\mathbf{X}) < 0$  for all  $i=1, \dots, n$ ):

3                 the global optimizer is configured to perform the Newton method, wherein  
4                 performing the Newton method involves,

5                         computing the Jacobian  $\mathbf{J}(\mathbf{x}, \mathbf{X})$  of the gradient of the  
6                         function  $f$  evaluated with respect to a point  $\mathbf{x}$  over the sub-box **X**,

7                         computing an approximate inverse **B** of the center of  
8                          $\mathbf{J}(\mathbf{x}, \mathbf{X})$ , and

9                         using the approximate inverse **B** to analytically determine  
10                  the system  $\mathbf{B}\mathbf{g}(\mathbf{x})$ , wherein  $\mathbf{g}(\mathbf{x})$  is the gradient of the function  $f(\mathbf{x})$ ,  
11                  and wherein  $\mathbf{g}(\mathbf{x})$  includes components  $g_i(\mathbf{x})$  ( $i=1, \dots, n$ ); and

12                  the term consistency mechanism is configured to,

13                         apply term consistency to each component  $(\mathbf{B}\mathbf{g}(\mathbf{x}))_i = 0$   
14                         ( $i=1, \dots, n$ ) for each variable  $x_i$  ( $i=1, \dots, n$ ) over the sub-box **X**, and to  
15                         exclude any portion of the sub-box **X** that violates a  
16                         component.

1                 29 (Canceled).

1                 30. (Original) The apparatus of claim 21, wherein the global optimizer is  
2                 configured to apply the Newton method to the John conditions.